

Application No. 10/628,134  
Amendment dated May 23, 2006  
After Final Office Action of March 24, 2006

## REMARKS

Reconsideration of the Application is respectfully requested.

## **I. Status of the claims**

Claims 1 and 3 have been amended, no new matter has been added.

Claim 6 has been cancelled without prejudice or disclaimer of the subject matter therein.

Claims 7-24 have been withdrawn from consideration.

Claims 1-5 and 25 are presently examined.

## II. Status of Claim 3

Applicants note that the rejections under 35 U.S.C. § 112 to claim 3 have been overcome and no other rejection based on informalities are listed. Further, claim 3 is not now or previously rejected on prior art grounds. Applicants contend that claim 3 is allowable over the art of record and have placed the claim in independent form. Applicants request that either claim 3 is identified as allowable or the grounds for the rejection of claim 3 be presented in a new action and the time period for response is reset.

### III. Rejections under 35 U.S.C. §102

Claims 1, 2, 4, and 6 are rejected under 35 U.S.C. §102(b) as being anticipated by Cerutti et al. (“Cerutti”) (US 5,273,557) or Fuller et al. (“Fuller”) (US 4,919,220). Claims 1, 4, and 6 are also rejected under 35 U.S.C. §102(b) as being anticipated by Cho et al. (“Cho”) (US 5,151,107) or General Electric (EP 402 671). Claim 6 has been cancelled and its elements incorporated into claim 1. Applicants respectfully traverse the rejections.

. In the response to the previous Office Action dated December 27, 2005, Applicants argued that a presence of diffusion layer in the bonding structure of claim 1 could not be anticipated by any reference cited by the Examiner. The Examiner currently asserts that Applicants' argument that technology of Cerutti, Fuller, and General Electric were conventional brazing were not acceptable, since the Examiner interpreted the language of claims to not distinguish over the prior art.

However, in the former arguments, Applicants explained that none of documents recited by the Examiner included a description of a *diffusion layer*, the presence of which was and is clearly described in claims of the present application. The presence/absence of the diffusion layer is a feature clearly distinguishing a bonding layer in a bonding structure of the present application and that of the prior art. Applicants respectfully submit an explanation below as to why the diffusion layer of the present application cannot be formed by brazing described in Cerutti, Fuller, and General Electric.

The Examiner described that each documents described a “wetting of the substrate and a diamond layer.” However, wetting does not does not equate to the formation of a diffusion layer. Wetting is a phenomena related to an interface between the blazing alloy and a substrate. When a blazing alloy spreads smoothly on a surface of the substrate without being detached from the substrate by a surface tension of molten alloy, the state is described that “the substrate is wetted by the brazing alloy.” That is, *wetting does not equate to diffusion* of metallic element of the alloy into the substrate.

Explanation of a diffusion layer

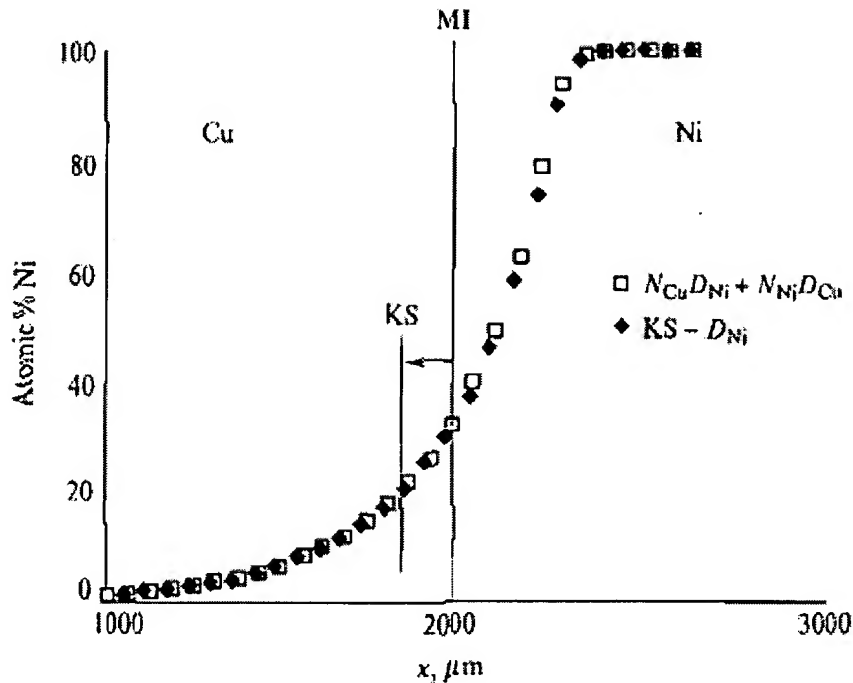
The claims of the present application clearly recite the presence of diffusion layer in the bonding layer. In the diffusion layer, metal diffuses into the carbide, or into the diamond. In solid state material science, “diffusion” is a well known term indicating a well known concept. Therefore, the meaning of the term “diffusion layer” is know to those of ordinary skill in the art.

For example, in a simple approximation, a migration length  $x$  of an atom by diffusion in a time period of  $t$  may be expressed by a formula:

$$x = (D \cdot t)^{1/2}$$

where,  $x$  is a migration length,  $t$  is time, and  $D$  is a diffusion coefficient related to a material property, temperature, pressure or the like. Note that the present application and claims are not limited by the above formula. However, the formula is sufficient to show that diffusion is a time-dependent phenomenon.

Since migration length of an atom is dependent on a time, when diffusion occurs between two different materials, compositional distribution of an element across the interface between the two materials change from discontinuous stepwise distribution to continuous distribution which is called a diffusion profile. In support this explanation, Applicants submit a figure in a text book as an example of a diffusion profile below. (Fig. 2.3 from *Stability of Microstructure in Metallic Systems*, 1997, Martin et al. Eds., Cambridge University Press, p 37. The figure shows a diffusion profile of Ni at Cu-Ni interface. Bibliographic information and page 37 attached hereto as Exhibit A).



**Figure 2.3** Composition profile of nickel in the interdiffusion at 1323 K for 312 h of pure copper initially at  $x \leq 1995 \mu\text{m}$ , and pure nickel, at  $x \geq 1995 \mu\text{m}$ , simulated (i) by the individual diffusion coefficient,  $D_{\text{Ni}}$  in the Kirkendall shift modified diffusion equation, eqs. (2.4b) as 'KS'  $D_{\text{Ni}}$  and (ii) by use of Darken's expression for the interdiffusion coefficient, eq. (2.10) in the standard diffusion equation, eq. (2.4a), as  $N_{\text{Cu}}D_{\text{Ni}} + N_{\text{Ni}}D_{\text{Cu}}$ . The Matano interface, found at the initial interface at  $1995 \mu\text{m}$ , is shown as the vertical line and the shift of the interface markers is indicated by the arrow marked KS. The two profiles are identical. Doherty (1993).

From the elements in the claims of the present application, it is obvious to one of ordinary skill in the art that in the diffusion layer of claim 1, a distribution of metallic composition changes continuously from a metal composition (or metal-rich composition) to a composition of the cemented carbide or the diamond.

Applicants further submit the differences between a diffusion layer and brazing with good wetting. The following is schematic drawings indicating a difference between a bonding structure

having diffusion layers, and a bonding structure by brazing. It should be noted, the present application and claims are not limited by the drawing.

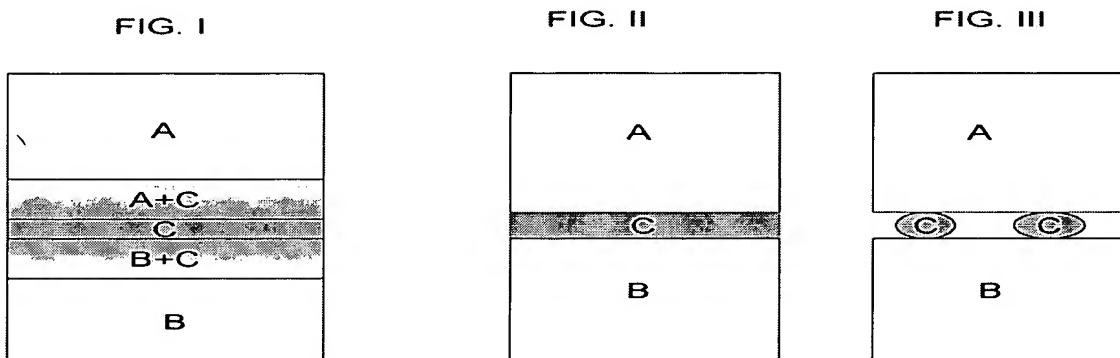


FIG. 1 exemplifies a case in which a metal C is inserted between two materials A and B, and diffusion layers are formed between the metal and the materials. Each diffusion layer contains an element composing the material (A or B) and a metallic element (C), and concentration of the metallic element changes continuously in the diffusion layer.

In contrast, FIG. II, and FIG. III exemplify cases in which two materials A and B are bonded with each other using a brazing alloy C. In general, distribution of a metallic element changes discontinuously at the interface between A and C, or B and C. When the brazing is performed with a good wetting, molten alloy C spreads smoothly at the interface, while metal C is detached from the interface when the molten alloy does not have good wetting property.

Regarding the bonding strength, a bonding structure comprising a diffusion layer in which composition (and property) changes continuously has a superior bonding strength compared with a brazed bonding with good wetting property.

### Distinguishing Cerutti from Claim 1 of the present application

Cerutti discloses a polycrystalline diamond compact directly brazed to the drill bit. In this case, the polycrystalline diamond compact is not supported with tungsten carbide or the like (column 3, lines 33-35). Therefore, Cerutti does not disclose a bonding structure of a cemented carbide and a diamond. Regarding the description of wetting (column 3, lines 34-35) recited by the Examiner, the related part (column 3, lines 33-46) merely describes that the polycrystalline diamond compact can be coated with a metal to confirm wetting of the diamond by brazing alloy. One of ordinary skill in the art is aware that the description in Cerutti has no relation to the diffusion layer of the present application, as claimed.

### Distinguishing Fuller from Claim 1 of the present application

Fuller describes bonding of polycrystalline diamond cutting element and tungsten carbide. The description recited by the Examiner (column 4, lines 59-60), describes that element of the brazing alloy “will react with the surface of the cutting element and react with diamond (carbon atom) to form a carbide layer.” In this description, “wetting” is a surface phenomena between the diamond cutting element and the brazing alloy by a reaction of metallic element with surface carbon atoms of diamonds.

For example, FIG. 8 corresponds to a description of an embodiment (column 6, lines 4-16) in which cutting element (diamond) 30 is bonded to the backing element (cemented carbide) 31 by brazing, with metallic shim 34 sandwiched between the cutting element and the backing element. In FIG. 8, no substantially recognizable layer is formed between the diamond 30 and brazing alloy 35, or between the tungsten carbide 31 and the brazing alloy 35.

### Distinguishing General Electric from Claim 1 of the present application

General Electric describes a brazing of a diamond layer formed by CVD to a tungsten carbide. The description recited by the Examiner (column 8, line 47) describes melting a braze (brazing alloy) and bonding it to a diamond layer and a carbide layer. However, recited description (column 8, line 48) also describes that the brazing operation is accomplished in a matter of seconds. Such a short period of time is not sufficient to form a substantial diffusion layer by a time-dependent diffusion process.

### Distinguishing Cho from Claim 1 of the present application

The cutting element described in Cho is a compact of diamond grains respectively coated with metal coatings such as tungsten (column 4, lines 17-26). Optionally uncoated particles may be dispersed between the coated particles (column 4, lines 37-42). The matrix of the compact may comprise a binding aid. As a binding aid, Co is less preferable because of decreased mechanical properties and thermal properties (Column 4, line 33-36).

The description recited by the Examiner is related to an embodiment in which the compact comprises a coated diamond, uncoated diamond, and Co as a binding aid. An example of such an embodiment is described in Example 1.

The description recited by the Examiner (Column 9, 1-3), is not related to a bonding structure between the diamond-rich compact and the cemented carbide element, but is related to internal texture of the compact. From the related description (column 8, lines 65 to column 9, line 4), and from the description of Example 1 (column 12, lines 54-57), it is obvious that the recited

part merely describes an effect of containing uncoated diamond by which reduction of thermal stability caused by a presence of Co can be inhibited. That is, the description is not related to the bonding structure of diamond element and cemented carbide element.

In addition, as was described in the former arguments, the description of Co diffusion in this part relates to a broad diffusion having influence on a whole portion of the diamond-bearing compact. A diffusion layer as a constituent of a bonding structure of a diamond element and a cemented carbide element is not described in Cho. As shown in the description of Example 1 (column 12, lines 10-18), Co cemented tungsten carbide is placed on raw materials of diamond-bearing compact before compaction, and subsequently compacted. In such operation, Co is dispersed in whole portion of the compact and does not form a recognizable diffusion layer having obvious diffusion profile.

Independent claim 1, and claims 2, 4, and 25 depending on claim 1, describes a bonding layer in which a region of a cemented carbide element or a diamond element influenced by the diffusion has distinguishable difference in metal content compared with a region of a cemented carbide element or a diamond element not influenced by the diffusion. Therefore, the diffusion layer of claims 1, 2, 4 and 25 can be clearly distinguished from the description of Cho. in which Co broadly diffuses to whole portion of the compact and does not form a recognizable diffusion layer.

Further amended claim 1 describes a bonding structure based on a result of line analysis using EPMA. Because of limitation on spatial resolution of EPMA, line profile across very thin layer (for example, nanometer size layer) cannot be obtained by EPMA. Therefore, by the current





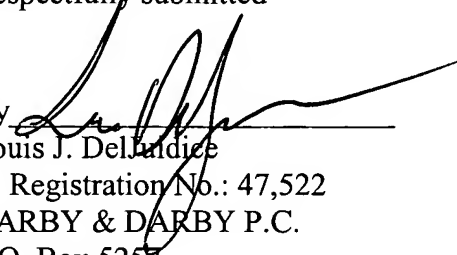
**CONCLUSION**

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

The Examiner is respectfully requested to contact the undersigned at the telephone number indicated below once he has reviewed the proposed amendment if the Examiner believes any issue can be resolved through either a Supplemental Response or an Examiner's Amendment.

Dated: May 23, 2006

Respectfully submitted

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# Stability of microstructure in metallic systems

Second edition



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The local volume,  $\Delta x'$  or  $\Delta V'$ , changes by virtue of creation or destruction of vacancies, when  $D_A \neq D_B$  in substitutional diffusion. So in a system such as Ni-Cu, where  $D_{\text{Cu}} > D_{\text{Ni}}$ , there is a reduction of the local lengths in the copper rich regions due to the net loss of atoms or, more accurately, atom sites. The net loss of atom sites results in negative values of  $d(\Delta x')/dt$  so producing an *increase* in the solute composition, eq. (2.4b). Figs. 2.3–2.5 show the results of two numerical simulations of Ni-Cu interdiffusion at 1323 K for 312 h, a situation previously studied experimentally by da Silva and Mehl (1951). In fig. 2.3 the interdiffusion had been simulated both using the standard equation, eq. (2.4a), with the Darken form of the interdiffusion coefficient,  $D$ , eq. (2.10), and also using the modified (lattice) diffusion equation, eq. (2.4b), but with the individual diffusion coefficients,  $D_{\text{Cu}}$  or  $D_{\text{Ni}}$ , for profiles calculated for either element as the solute A. It is clear that both simulations give identical profiles and these profiles were found to be almost identical to the experimental profile. Fig. 2.4 gives the simulated Kirkendall marker shifts for markers placed at the initial interface – these markers move into copper with a displacement that scales with the square root of time with a constant composition as seen experimentally. The magnitude of both the shift and the local composition at the interface markers also matched the experimental values reported by da Silva and Mehl (1951). Movement of

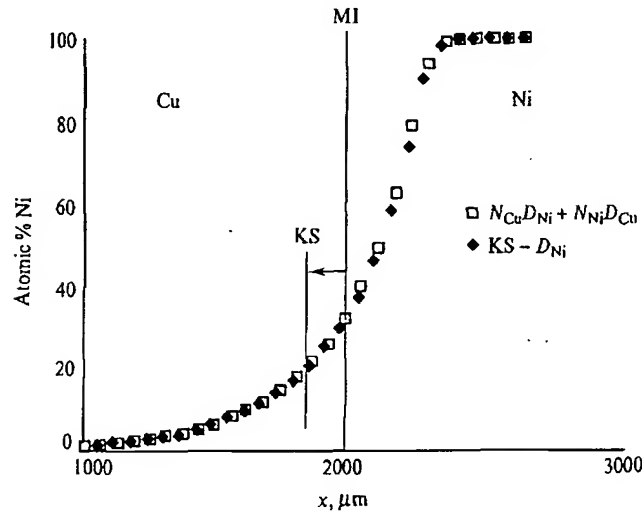


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